CGC, Inc.

Construction • Geotechnical
Consulting Engineering/Testing

January 21, 2022
C21051-29

Mr. Randy Wiesner
Facilities Management & Sustainability
City of Madison Engineering Division
210 Martin Luther King, Jr. Blvd., Room 115
Madison, WI 53703

Re: Geotechnical Exploration Report
Proposed Salt Barn
1501 West Badger Road
Madison, Wisconsin

Dear Mr. Wiesner:

Construction • Geotechnical Consultants, Inc. (CGC) has completed the geotechnical exploration program for the project referenced above. The purpose of this exploration program was to evaluate the subsurface conditions within the proposed construction area and to provide geotechnical recommendations regarding site preparation, foundation, floor slab and pavement design/construction. We are sending you an electronic copy of this report and can provide a paper copy upon request.

PROJECT DESCRIPTION

We understand that a slab-on-grade building is proposed to replace the existing salt storage structures. Finish floor elevation was not available at the time of this submittal but is assumed will be similar to the existing buildings at about EL 889 ft. Based on a finish floor at EL 889 ft, footings are generally expected to bear near EL 885 ft. Although not provided, we assume building loads will be light to moderate with maximum column loads of less than 100 kips and wall loads of less than 3 kips/ft.

SITE CONDITIONS

The site is located on the south side of W. Badger Road within a City of Madison Streets Division parcel which contains multiple structures surrounded by asphalt pavement. The proposed area of construction within the southeastern portion of the site is relatively flat adjacent to a gently-sloping downward profile trending from south to north. Site grades range from about EL 890 ft in the southwestern corner to about EL 883 ft near the northern entrance at the driveway along West Badger Road.

2921 Perry Street, Madison WI 53713
Telephone: 608/288-4100
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SUBSURFACE CONDITIONS

Subsurface conditions on site were explored by drilling two Standard Penetration Test (SPT) borings to planned depths of 20 ft below existing site grades. The borings were drilled by Badger State Drilling (under subcontract to CGC) on December 3, 2021 using a truck mounted CME-55 rotary drill rig equipped with hollow stem augers and an automatic SPT hammer. Note, that split-spoon (but not auger) refusal occurred in both of the borings beginning between 13 and 14 ft below present ground surface. Elevations at the boring locations were estimated using topographic information obtained from Dane County DCi Map, which should be considered approximate (+/- 1 ft). The boring locations are shown in plan on the Soil Boring Location Map attached in Appendix B.

The subsurface profiles at the boring locations were fairly similar, and a generalized profile includes the following strata, in descending order:

- 6 to 8 in. of ***asphalt pavement*** atop 10 to 12 in. of ***base course***; over
- About 4 to 7 ft of ***fill*** consisting primarily of granular materials in very loose to very dense conditions with silt and clay (having a layer of asphalt or recycled asphalt slightly above the transition to native soils at B1); underlain by
- About 2.5 to 5.5 ft of medium dense ***silty granular soils***; followed by
- Very dense weathered to competent light tan to white ***sandstone bedrock*** beginning at depths of 11 to 12 ft below existing grades and resulting in split-spoon (but not auger) refusal near 13.5 ft. The bedrock becomes more competent with depth.

Groundwater was not encountered in the borings during or shortly after drilling. Groundwater levels are expected to fluctuate with seasonal variations in precipitation, infiltration, evapotranspiration as well as other factors. A more detailed description of the site soil and groundwater conditions is presented on the Soil Boring Logs attached in Appendix B, while Appendix A describes additional drilling program details.

DISCUSSION AND RECOMMENDATIONS

Subject to the limitations discussed below and based on the subsurface exploration, it is our opinion that the site is suitable for the proposed construction and that the structure can be supported by conventional spread footing foundations. *However, we recommend a contingency be included in the project budget for some undercutting of potential loose fill materials below the floor slab and footings.* Our recommendations for site preparation, foundation, floor slab and pavement design/construction are presented in the following subsections. Additional information regarding the conclusions and recommendations presented in this report is discussed in Appendix C.

1. Site Preparation

We recommend that the pavement be stripped/removed at least 5 ft beyond the proposed construction areas, including areas required for cuts and fills beyond the proposed building footprint or pavement limits. The soils below the pavement/base course are generally expected to consist of variably silty granular fill at times mixed with clay. The exposed subgrade should be recompacted with a smooth-drum vibratory roller and then evaluated for stability by proof-rolling with a loaded tri-axle dump truck. If soft/yielding areas are encountered, an initial attempt could be made to dry and recompact the soils if appropriate weather conditions exist. Otherwise, unstable areas should be undercut and replaced with well-compacted coarse aggregate (e.g., 3-in. dense graded base, select crushed material or breaker run stone). Based on the presence of shallow fill soils, some of which were in a very loose condition, we recommend that the project budget include a contingency for undercutting/stabilization to develop a stable subgrade.

After the existing soils have been recompacted and stabilized, fill placement to establish planned grades (if necessary) can begin. We recommend using granular soils as fill within building areas and upper 3 ft in pavement areas, as sand/gravel are generally easier to place and compact in a wider range of weather conditions. We generally do not recommend using silt/clay soils as fill within building or pavement areas, as moisture conditioning is typically required to achieve required compaction levels, often resulting in construction delays. In our opinion, silt/clay soils are best used as fill in landscaped areas or otherwise hauled off site. The new fill within the building footprint and upper 3 ft of pavement areas should be compacted to a minimum of 95% compaction based on modified Proctor methods (ASTM D 1557). Periodic field density tests should be taken by CGC staff within the fill/backfill to document the adequacy of compactive effort.

2. Foundation Design

In our opinion, the building can be supported on reinforced concrete spread footing foundations bearing on natural granular, cohesive or possibly thoroughly recompacted fill soils. *Some undercutting may be necessary due to fill extending 5 to 8 ft below existing grades and a contingency should be included in the project budget.* The following parameters should be used for foundation design:

- Maximum net allowable bearing pressure: 2,000 psf
- Minimum foundation widths:
  - -- Continuous wall footings: 18 in.
  - -- Column pad footings: 30 in.
- Minimum footing depths:
  - -- Exterior/perimeter footings: 4 ft
  - -- Interior footings: no minimum requirement

Undercutting below footing grade should be expected due to the 5 to 8 ft of existing, non-engineered fill and will also be required where native loose sand/silt or native clay with pocket penetrometer readings (an estimate of the unconfined compressive strength of cohesive soil) of less than 1.0 tsf are encountered at or slightly below footing grade. Additional undercutting of the native loose to very loose sand and silt encountered below the fill in Boring 2 may be necessary if footings bear within or just above this layer. Conversely, the dense to very dense conditions present in the fill materials present at B1 may prove suitable for footing support after recompaction and evaluation. Where undercutting is required, the base of the undercut excavation should be widened beyond the footing edges at least 0.5 ft in each direction for each foot of undercut depth for stress distribution purposes. Footing grade can be restored with granular backfill densified to at least 95% compaction (modified Proctor - ASTM D1557) or 3-in. dense graded base that is placed in maximum loose lifts of 12 in. and thoroughly compacted with a large vibratory compactor until deflection ceases. Additional compaction details are discussed in Appendix D.

CGC should be present during footing excavations to check whether the subgrades are satisfactory for the design bearing pressure and to advise on corrective measures, where necessary. We recommend using a smooth-edged backhoe bucket for footing excavations in soil. Additionally, granular soils exposed at footing grade should be recompacted with a large vibratory plate compactor prior to formwork/concrete placement to densify soils loosened during the excavation process. Soils potentially susceptible to disturbance from compaction (e.g., silty or clayey soils) should be hand trimmed. Provided the foundation design/construction recommendations discussed above are followed, including early fill placement, we estimate that total and differential settlements should be on the order of 1.0 and 0.5 in., respectively.

3. Floor Slab

For a floor slab grade near EL 889 ft, the subgrade soils are expected to consist of recently compacted base course, granular fill or newly-placed engineered granular fill. Prior to slab construction, the subgrades should be thoroughly proof-rolled/recompacted to densify soils that may have been disturbed or loosened during construction activities. Areas that remain loose or yielding after recompaction should be undercut and replaced with compacted 3-in. dense graded base or granular fill. The design subgrade modulus is based on a recompacted subgrade such that non-yielding conditions are developed.

To act as a capillary break below the slab, the final 4 to 6 in. of soil placed below the slab should consist of well-graded sand/gravel with no more than 5 percent by weight passing a No. 200 U.S. standard sieve. (Note that some structural engineers require a 4 to 6 in. layer of ¾ in. or 1-¼ in. dense graded base immediately below the slab to increase the subgrade modulus.) Fill and base layer material below the floor slab should be placed as described in the Site Preparation section of this report. A subgrade modulus of 100 pci may be used for slab design if the slab is supported on well-graded sand/gravel over a firm subgrade. To further minimize the potential for moisture migration, a plastic vapor barrier can also be utilized below the slab. The slab should be structurally separate from the foundations and have construction joints and reinforcement for crack control.

4. Seismic Design Category

In our opinion, the average soil/rock properties in the upper 100 ft of the site (based on the presence of shallow bedrock) may be characterized as a very dense soil and soft rock profile. This characterization would place the site in Site Class C for seismic design according to the International Building Code (see Table 1613.5.2).

5. Pavement Design

We anticipate the pavement subgrade will consist of existing or newly-placed, compacted base course, sand and/or clay fill. The pavement areas should be proof-rolled, as discussed in the Site Preparation section of this report, to check for unstable areas that will require undercutting/replacement or stabilization with coarse aggregate (e.g., 3-in. dense graded base, select crushed material, etc., as described in Appendix D).

We assume that parking lot areas will experience relatively light traffic loads consisting primarily of cars and light trucks/vans (e.g., less than one equivalent 18-kip single-axle load - ESAL), with drive lanes around the building experiencing slightly higher truck traffic loads (e.g., less than 5 ESALs). Note that for the heavier pavement section in truck traffic areas, we have included two approximately equivalent sections – a thicker unreinforced section and a thinner geogrid-reinforced section. The silty soils will control the pavement thickness design. Accordingly, the pavement sections tabulated below were selected assuming a CBR value of approximately 5 to 9 and a design life of 20 years.

TABLE 1
RECOMMENDED PAVEMENT SECTIONS

Material	Thickness (in.)			WisDOT Specification
	Car Parking - Less than 1 ESAL	Drive Lanes and Truck Traffic Areas - Less than 5 ESALs		
		Unreinforced	Reinforced	
Bituminous upper layer	1.5	1.5	1.5	Section 460, Table 460-1, 12.5 mm
Bituminous lower layer	1.5	2.5	2.5	Section 460, Table 460-1, 19.0 mm
Dense graded base (Crushed aggregate base course)	8.0	10.0	8.0	Sections 301 and 305, 75 mm and 31.5mm
Geogrid reinforcement	No	No	Yes	Tensar TX5 Triaxial Geogrid
TOTAL THICKNESS	11.0	14.0	12.0	

Notes:

1. Wisconsin DOT *Standard Specifications for Highway and Structure Construction*, latest edition, including supplemental specifications, but excluding Section 460.3.2 relating layer thickness to aggregate size.

2. Compaction requirements:
   - Bituminous concrete: Refer to Section 460-3.
   - Base course: Refer to Section 301.3.4.2, Standard Compaction

3. Mixture Type E-0.3 bituminous pavement is recommended; refer to Section 460, Table 460-2 of the *Standard Specifications.*

Note that if traffic volumes are greater than those assumed, CGC should be allowed to review the recommended pavement sections and adjust them accordingly. The pavement design assumes a stable/non-yielding subgrade and a regular program of preventative maintenance. Alternative pavement designs may prove applicable and should be reviewed by CGC. If there is a delay between subgrade preparation and placing the base course, the subgrade should be recompacted.

Pavement areas subjected to concentrated wheel loads (i.e., barn entrance, loading dock aprons, dumpster pads, etc.) should be constructed of Portland cement concrete. The slab should be a minimum of 6-in. thick, be underlain by at least 6 in. of dense graded base and contain reinforcement for crack control. A subgrade modulus of 100 pci should be used for concrete pavement design on proof-rolled/recompacted sand, silt or clay subgrades.

CONSTRUCTION CONSIDERATIONS

Due to variations in weather, construction methods and other factors, specific construction problems are difficult to predict. Soil related difficulties that could be encountered on the site are discussed below:

- Due to the potentially sensitive nature of the on-site soils, we recommend that final site grading activities be completed during dry weather, if possible. Construction traffic should be avoided on prepared subgrades to minimize potential disturbance.

- Earthwork construction during the early spring or late fall could be complicated as a result of wet weather and freezing temperatures. During cold weather, exposed subgrades should be protected from freezing before and after footing construction. Fill should never be placed while frozen or on frozen ground.

- Excavations extending greater than 4 ft in depth below the existing ground surface should be sloped or braced in accordance with current OSHA standards.

- If excavating next to an existing building, take care to avoid undermining the existing footings.

- Based on observations made during the field exploration, we generally do not expect that groundwater will be encountered in the building excavation. However, water accumulating at the base of excavations as a result of precipitation or seepage should be controlled and quickly removed using pumps operating from shallow sump pits.

RECOMMENDED CONSTRUCTION MONITORING

The quality of the foundation, floor slab and pavement subgrades will be largely determined by the level of care exercised during site development. To check that earthwork and foundation construction proceeds in accordance with our recommendations, the following operations should be monitored by CGC:

- Topsoil stripping/subgrade proof-rolling within the construction areas;
- Fill/backfill placement and compaction;
- Foundation excavation/subgrade preparation; and
- Concrete placement.

* * * * *

It has been a pleasure to serve you on this project and we look forward to working with you as it proceeds. If you have any questions or need additional consultation, please contact us.

Sincerely,

CGC, Inc.

Eric S. Fair
Senior Staff Engineer/Geologist

Michael N. Schultz, P.E.
Principal/Consulting Professional

Encl: Appendix A - Field Exploration
Appendix B - Boring Location Map
Logs of Test Borings (2)
Log of Test Boring-General Notes
Unified Soil Classification System
Appendix C - Document Qualifications
Appendix D - Recommended Compacted Fill Specifications

APPENDIX A

FIELD EXPLORATION

APPENDIX A

FIELD EXPLORATION

Two Standard Penetration Test (SPT) borings were drilled to planned depths of 20 ft below existing site grades within or directly adjacent to the building footprint. The borings were drilled by Badger State Drilling (under subcontract to CGC) on December 3, 2021 using a truck mounted CME-55 rotary drill rig equipped with hollow stem augers and an automatic SPT hammer. Note that split-spoon refusal occurred during sampling in both of the borings beginning approximately 13.5 ft below present grades. However, auger refusal did not occur at either location. Ground surface elevations at the boring locations were estimated using topographic information obtained from Dane County DCi Map, which should be considered approximate (+/- 1 ft). The boring locations are shown in plan on the Boring Location Map attached in Appendix B.

In each boring, soil samples were obtained at 2.5 foot intervals to a depth of 10 ft and at 5 ft intervals thereafter. The soil samples were obtained in general accordance with specifications for standard penetration testing, ASTM D 1586. The specific procedures used for drilling and sampling are described below.

1. Boring Procedures between Samples
   The boring is extended downward, between samples, by a hollow-stem auger.

2. Standard Penetration Test and Split-Barrel Sampling of Soils
   (ASTM Designation: D 1586)

   This method consists of driving a 2-inch outside diameter split-barrel sampler using a 140-pound weight falling freely through a distance of 30 inches. The sampler is first seated 6 inches into the material to be sampled and then driven 12 inches. The number of blows required to drive the sampler the final 12 inches is recorded on the log of borings and is known as the Standard Penetration Resistance.

During the field exploration, the driller visually classified the soil and prepared a field log. *Field screening of the soil samples for possible environmental contaminants was not conducted by the drillers as environmental site assessment activities were not part of CGC's work scope.* Water level observations were made in each boring during and after drilling and are shown at the bottom of each boring log. Upon completion of drilling, the borings were backfilled with bentonite (where required) to satisfy WDNR regulations and the soil samples were delivered to our laboratory for visual classification and laboratory testing. The soil samples were visually classified by a geotechnical engineer using the Unified Soil Classification System. The final logs prepared by the engineer and a description of the Unified Soil Classification System are presented in Appendix B.

APPENDIX B

BORING LOCATION MAP
LOGS OF TEST BORINGS (2)
LOG OF TEST BORING-GENERAL NOTES
UNIFIED SOIL CLASSIFICATION SYSTEM

Legend

Denotes Boring Location

Notes

1. Soil Borings performed by Badger State Drilling in December 2021
2. Boring locations are approximate

Scale: Reduced

Job No. C21051-29	CGC, Inc.	SOIL BORING LOCATION MAP **West Badger Road Salt Barn** **Madison, Wisconsin**
Date: 12/2021		

CGC Inc.

LOG OF TEST BORING

Project: West Badger Road Salt Barn

Location: Madison, WI

Boring No. 1
Surface Elevation (ft) 889±
Job No. C21051-29
Sheet 1 of 1

2921 Perry Street, Madison, WI 53713 (608) 288-4100, FAX (608) 288-7887

SAMPLE No.	Type	Rec (in.)	Moist	N	Depth (ft)	VISUAL CLASSIFICATION and Remarks	qu (qa) (tsf)	W	LL	PL	LI
						8 in. Asphalt Pavement/12 in. Base Course					
1		14	M	38							
						FILL: Dense to Very Dense Brown Silty Sand and Gravel with Traces of Clay to 7'					
2		4	M	50/5"							
					5						
3		14	M	31		Dense Recycled Asphalt to 7.5'					
						Medium Dense Brown Silty Sand and Gravel to 8'					
4		14	M	13		Medium Dense, Brown Fine to Medium SAND, Some Silt and Gravel, Scattered Cobbles and Boulders (SM)					
					10						
						Weathered to Competent, Light Tan to White Sandstone Bedrock					
5		8	M	76/8"							
					15						
6		5	M	50/5"							
					20	End Boring at 20 ft					
						Borehole backfilled with bentonite chips and asphalt patch					
					25						

WATER LEVEL OBSERVATIONS

While Drilling ∇ NW   Upon Completion of Drilling ____
Time After Drilling ____
Depth to Water ____
Depth to Cave in ____

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start 12/3/21 End 12/3/21
Driller BSD Chief MC Rig CME-55
Logger DD Editor ESF
Drill Method 2.25" HSA; Autohammer

LOG OF TEST BORING

CGC Inc.

Project	West Badger Road Salt Barn
Location	Madison, WI
Boring No.	2
Surface Elevation (ft)	889±
Job No.	C21051-29
Sheet	1 of 1

2921 Perry Street, Madison, WI 53713 (608) 288-4100, FAX (608) 288-7887

SAMPLE						VISUAL CLASSIFICATION and Remarks	SOIL PROPERTIES				
No.	TYPE	Rec (in.)	Moist	N	Depth (ft)		qu (qa) (tsf)	W	LL	PL	LI
					0–1.3	6 in. Asphalt Pavement/10 in. Base Course					
1		10	M	13		FILL: Medium Dense to Loose Brown Silty Sand with Gravel and Clay					
2		16	M	9							
					5	Loose to Very Loose Brown Stratified Silty SAND and Sandy SILT (SM/ML)					
3		16	M	4							
4		16	M	19		Medium Dense Fine to Medium Brown SAND, Some Silt and Gravel, Scattered Cobbles and Boulders (SM)					
					10	Weathered to Competent, Light Tan to White Sandstone Bedrock					
5		6	M	50/6"							
					15						
6				50/1"							
					20	End Boring at 20 ft Borehole backfilled with bentonite chips and asphalt patch					
					25						

WATER LEVEL OBSERVATIONS

While Drilling	▽ NW	Upon Completion of Drilling		
Time After Drilling				
Depth to Water				▼
Depth to Cave in				

The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

GENERAL NOTES

Start	12/3/21	End	12/3/21		
Driller	BSD	Chief	MC	Rig	CME-55
Logger	DD	Editor	ESF		
Drill Method	2.25" HSA; Autohammer				

CGC, Inc.

LOG OF TEST BORING

General Notes

DESCRIPTIVE SOIL CLASSIFICATION

Grain Size Terminology

Soil Fraction	Particle Size	U.S. Standard Sieve Size
Boulders	Larger than 12"	Larger than 12"
Cobbles	3" to 12"	3" to 12"
Gravel: Coarse	¾" to 3"	¾" to 3"
Fine	4.76 mm to ¾"	#4 to ¾"
Sand: Coarse	2.00 mm to 4.76 mm	#10 to #4
Medium	0.42 to mm to 2.00 mm	#40 to #10
Fine	0.074 mm to 0.42 mm	#200 to #40
Silt	0.005 mm to 0.074 mm	Smaller than #200
Clay	Smaller than 0.005 mm	Smaller than #200

Plasticity characteristics differentiate between silt and clay.

General Terminology

Physical Characteristics
Color, moisture, grain shape, fineness, etc.
Major Constituents
Clay, silt, sand, gravel
Structure
Laminated, varved, fibrous, stratified, cemented, fissured, etc.
Geologic Origin
Glacial, alluvial, eolian, residual, etc.

Relative Density

Term	"N" Value
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Over 50

Relative Proportions Of Cohesionless Soils

Proportional Term	Defining Range by Percentage of Weight
Trace	0% - 5%
Little	5% - 12%
Some	12% - 35%
And	35% - 50%

Consistency

Term	q_u-tons/sq. ft
Very Soft	0.0 to 0.25
Soft	0.25 to 0.50
Medium	0.50 to 1.0
Stiff	1.0 to 2.0
Very Stiff	2.0 to 4.0
Hard	Over 4.0

Organic Content by Combustion Method

Soil Description	Loss on Ignition
Non Organic	Less than 4%
Organic Silt/Clay	4 – 12%
Sedimentary Peat	12% - 50%
Fibrous and Woody Peat	More than 50%

Plasticity

Term	Plastic Index
None to Slight	0 - 4
Slight	5 - 7
Medium	8 - 22
High to Very High	Over 22

The penetration resistance, N, is the summation of the number of blows required to effect two successive 6" penetrations of the 2" split-barrel sampler. The sampler is driven with a 140 lb. weight falling 30" and is seated to a depth of 6" before commencing the standard penetration test.

SYMBOLS

Drilling and Sampling

CS – Continuous Sampling
RC – Rock Coring: Size AW, BW, NW, 2"W
RQD – Rock Quality Designation
RB – Rock Bit/Roller Bit
FT – Fish Tail
DC – Drove Casing
C – Casing: Size 2 ½", NW, 4", HW
CW – Clear Water
DM – Drilling Mud
HSA – Hollow Stem Auger
FA – Flight Auger
HA – Hand Auger
COA – Clean-Out Auger
SS - 2" Dia. Split-Barrel Sample
2ST – 2" Dia. Thin-Walled Tube Sample
3ST – 3" Dia. Thin-Walled Tube Sample
PT – 3" Dia. Piston Tube Sample
AS – Auger Sample
WS – Wash Sample
PTS – Peat Sample
PS – Pitcher Sample
NR – No Recovery
S – Sounding
PMT – Borehole Pressuremeter Test
VS – Vane Shear Test
WPT – Water Pressure Test

Laboratory Tests

q_a – Penetrometer Reading, tons/sq ft
q_a – Unconfined Strength, tons/sq ft
W – Moisture Content, %
LL – Liquid Limit, %
PL – Plastic Limit, %
SL – Shrinkage Limit, %
LI – Loss on Ignition
D – Dry Unit Weight, lbs/cu ft
pH – Measure of Soil Alkalinity or Acidity
FS – Free Swell, %

Water Level Measurement

▽ - Water Level at Time Shown
NW – No Water Encountered
WD – While Drilling
BCR – Before Casing Removal
ACR – After Casing Removal
CW – Cave and Wet
CM – Caved and Moist

Note: Water level measurements shown on the boring logs represent conditions at the time indicated and may not reflect static levels, especially in cohesive soils.

CGC, Inc.

Madison - Milwaukee

Unified Soil Classification System

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size)		
	Clean Gravels (Less than 5% fines)	
GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)	
	GM	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
	Clean Sands (Less than 5% fines)	
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	SW	Well-graded sands, gravelly sands, little or no fines
	SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)	
	SM	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size.)		
SILTS AND CLAYS Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils

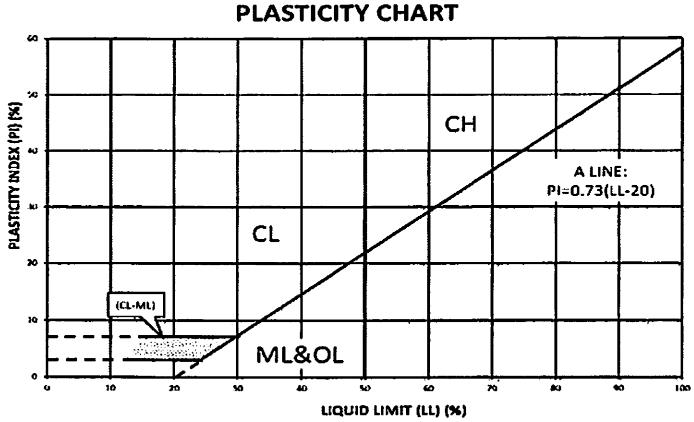
LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limts below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limts above "A" line or P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent .... GW, GP, SW, SP
More than 12 percent .... GM, GC, SM, SC
5 to 12 percent .... Borderline cases requiring dual symbols

PLASTICITY CHART



APPENDIX C

DOCUMENT QUALIFICATIONS

APPENDIX C
DOCUMENT QUALIFICATIONS

I. GENERAL RECOMMENDATIONS/LIMITATIONS

CGC, Inc. should be provided the opportunity for a general review of the final design and specifications to confirm that earthwork and foundation requirements have been properly interpreted in the design and specifications. CGC should be retained to provide soil engineering services during excavation and subgrade preparation. This will allow us to observe that construction proceeds in compliance with the design concepts, specifications and recommendations, and also will allow design changes to be made in the event that subsurface conditions differ from those anticipated prior to the start of construction. CGC does not assume responsibility for compliance with the recommendations in this report unless we are retained to provide construction testing and observation services.

This report has been prepared in accordance with generally accepted soil and foundation engineering practices and no other warranties are expressed or implied. The opinions and recommendations submitted in this report are based on interpretation of the subsurface information revealed by the test borings indicated on the location plan. The report does not reflect potential variations in subsurface conditions between or beyond these borings. Therefore, variations in soil conditions can be expected between the boring locations and fluctuations of groundwater levels may occur with time. The nature and extent of the variations may not become evident until construction.

II. IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes. While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. *No one except you* should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one - not even you* - should apply the report for any purpose or project except the one originally contemplated.

READ THE FULL REPORT

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, *do not rely on a geotechnical engineering report* that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes - even minor ones - and request an assessment of their impact. *CGC cannot accept responsibility or liability for problems that occur because our reports do not consider developments of which we were not informed.*

SUBSURFACE CONDITIONS CAN CHANGE

A geotechnical engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

MOST GEOTECHNICAL FINDINGS ARE PROFESSIONAL OPINION

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgement to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ - sometimes significantly - from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A REPORT'S RECOMMENDATIONS ARE NOT FINAL

Do not over-rely on the confirmation-dependent recommendations included in your report. *Those confirmation-dependent recommendations are not final*, because geotechnical engineers develop them principally from judgement and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *CGC cannot assume responsibility or liability for the report's confirmation-dependent recommendations if we do not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical engineering report. Confront that risk by having CGC participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

DO NOT REDRAW THE ENGINEER'S LOGS

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

GIVE CONSTRUCTORS A COMPLETE REPORT AND GUIDANCE

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

READ RESPONSIBILITY PROVISIONS CLOSELY

Some clients, design professionals, and constructors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineer's responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

ENVIRONMENTAL CONCERNS ARE NOT COVERED

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

OBTAIN PROFESSIONAL ASSISTANCE TO DEAL WITH MOLD

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

RELY ON YOUR GEOTECHNICAL ENGINEER FOR ADDITIONAL ASSISTANCE

Membership in the Geotechnical Business Council (GBC) of Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with CGC, a member of GBC, for more information.

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Geotechnical Business Council
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APPENDIX D

RECOMMENDED COMPACTED FILL SPECIFICATIONS

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CGC, INC.

RECOMMENDED COMPACTED FILL SPECIFICATIONS

General Fill Materials

Proposed fill shall contain no vegetation, roots, topsoil, peat, ash, wood or any other non-soil material which by decomposition might cause settlement. Also, fill shall never be placed while frozen or on frozen surfaces. Rock, stone or broken concrete greater than 6 in. in the largest dimension shall not be placed within 10 ft of the building area. Fill used greater than 10 ft beyond the building limits shall not contain rock, boulders or concrete pieces greater than a 2 sq ft area and shall not be placed within the final 2 ft of finish subgrade or in designated utility construction areas. Fill containing rock, boulders or concrete pieces should include sufficient finer material to fill voids among the larger fragments.

Special Fill Materials

In certain cases, special fill materials may be required for specific purposes, such as stabilizing subgrades, backfilling undercut excavations or filling behind retaining walls. For reference, WisDOT gradation specifications for various types of granular fill are attached in Table 1.

Placement Method

The approved fill shall be placed, spread and leveled in layers generally not exceeding 10 in. in thickness before compaction. The fill shall be placed at moisture content capable of achieving the desired compaction level. For clay soils or granular soils containing an appreciable amount of cohesive fines, moisture conditioning will likely be required.

It is the Contractor's responsibility to provide all necessary compaction equipment and other grading equipment that may be required to attain the specified compaction. Hand-guided vibratory or tamping compactors will be required whenever fill is placed adjacent to walls, footings, columns or in confined areas.

Compaction Specifications

Maximum dry density and optimum moisture content of the fill soil shall be determined in accordance with modified Proctor methods (ASTM D1557). The recommended field compaction as a percentage of the maximum dry density is shown in Table 2. Note that these compaction guidelines would generally not apply to coarse gravel/stone fill. Instead, a method specification would apply (e.g., compact in thin lifts with a vibratory compactor until no further consolidation is evident).

Testing Procedures

Representative samples of proposed fill shall be submitted to CGC, Inc. for optimum moisture-maximum density determination (ASTM D1557) prior to the start of fill placement. The sample size should be approximately 50 lb.

CGC, Inc. shall be retained to perform field density tests to determine the level of compaction being achieved in the fill. The tests shall generally be conducted on each lift at the beginning of fill placement and at a frequency mutually agreed upon by the project team for the remainder of the project.

Table 1
Gradation of Special Fill Materials

Material	WisDOT Section 311	WisDOT Section 312	WisDOT Section 305			WisDOT Section 209		WisDOT Section 210
	Breaker Run	Select Crushed Material	3-in. Dense Graded Base	1 1/4-in. Dense Graded Base	3/4-in. Dense Graded Base	Grade 1 Granular Backfill	Grade 2 Granular Backfill	Structure Backfill
Sieve Size	Percent Passing by Weight							
6 in.	100							
5 in.		90-100						
3 in.			90-100					100
1 1/2 in.		20-50	60-85					
1 1/4 in.				95-100				
1 in.					100			
3/4 in.			40-65	70-93	95-100			
3/8 in.				42-80	50-90			
No. 4			15-40	25-63	35-70	100 (2)	100 (2)	25-100
No. 10		0-10	10-30	16-48	15-55			
No. 40			5-20	8-28	10-35	75 (2)		
No. 100						15 (2)	30 (2)	
No. 200			2-12	2-12	5-15	8 (2)	15 (2)	15 (2)

Notes:
1. Reference: Wisconsin Department of Transportation *Standard Specifications for Highway and Structure Construction.*
2. Percentage applies to the material passing the No. 4 sieve, not the entire sample.
3. Per WisDOT specifications, both breaker run and select crushed material can include concrete that is 'substantially free of steel, building materials and other deleterious material'.

Table 2
Compaction Guidelines

Area	Percent Compaction (1)	
	Clay/Silt	Sand/Gravel
Within 10 ft of building lines		
Footing bearing soils	93 - 95	95
Under floors, steps and walks		
- Lightly loaded floor slab	90	90
- Heavily loaded floor slab and thicker fill zones	92	95
Beyond 10 ft of building lines		
Under walks and pavements		
- Less than 2 ft below subgrade	92	95
- Greater than 2 ft below subgrade	90	90
Landscaping	85	90

Notes:
1. Based on Modified Proctor Dry Density (ASTM D 1557)